ERIC Document Resume	See Instruction Sheet	DATE OF RESUME	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.	DO NOT WRITE IN SPACE BELOW
ED002306	N.A.	1129	

4. AUTHOR(S): Coulson, John E., and others

5. TITLE OF DOCUMENT ABSTRACTED: Effects of Branching in a Computer-Controlled Auto-Instructional Device

6. PUBLICATION TITLE: N.A.

7. EDITOR(S): N.A.

9. PUBLISHER OR SOURCE: System Development Corporation, 2500 Colorado Avenue Santa Monica, California

8. PLACE OF ORIGIN
ORG. System Development Corporation
ST. 2500 Colorado Ave.
CITY, STATE Santa Monica, California
TELE. EXT.
INST/LOC CODE

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
N.A.	N.A.	5/61	8

MICROFILM COPY AVAILABLE YES ☒ NO ☐

COPYRIGHT GRANTED YES ☒ NO ☐

COPYRIGHT RELEASE FILED YES ☒ NO ☐

TYPE OF REPORT
PROPOSAL ☐
IN-PROGRESS ☐
FINAL ☒
FOLLOW-UP ☐

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR: Report

16. INDEXING TERMS (6-12)

auto-instructional	device	fixed sequence programs	computers	
auto-instruction		teaching machines	Bendix G-15 computer	
branching programs		programed learning		
		instructional technology		

17. ABSTRACT (MAX. 250 WORDS)

A study on the the effectiveness of using both the student's errors on training items and his own evaluation of his learning progress was presented.

Two groups of 15 high school students were given automated instruction on logic by means of a flexible sequence, computer-controlled auto-instructional device. One group was designated the fixed-sequence group, and the other was termed the branching group. Every member of the fixed-sequence group received the identical sequence of 233 instructional items. Each student in the branching group was given a different number and sequence of items, depending on his performance in responding to certain items during the lesson, and on the student's self-evaluation of his own progress. At the conclusion of the lesson a written criterion test was given covering the material in the lesson. This test was the same for all members of both groups.

The auto-instructional device used consisted of a general purpose digital computer coupled to a random-access slide projector and an electric typewriter. The 345 instructional items on logic included simple and compound statements, logical connectives, and six argument forms.

Members of the branching group averaged 8.9 points higher on the criterion test, and required an average of 13.3 minutes less training time. The difference in criterion performance was significant at the .05 level. The difference in training time did not reach significance. The correlation between aptitude score and post-training score was not significant for either group nor for the two groups combined.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION	20. DIVISION OR DEPT.	21. CONTRACT NO. / PROJECT NO.
	22. TOTAL COST OF PROJECT	
	23. DURATION OF PROJECT	U.S. Department of Health, Education, and Welfare Office of Education

1129

ED002306

1129

TM-617

Effects of Branching in a Computer Controlled Auto-Instructional Device

12 May 1961

REPRINTED BY PERMISSION
U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN PRINTED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

TM-617

INSTRUCTIONAL TECHNOLOGY - U.S.C.

REPRINT

TECHNICAL MEMORANDUM

(TM Series)

Effects of Branching in a Computer Controlled Auto-Instructional Device

by

John E. Coulson, Donald P. Estavan
Ralph J. Melaragno, Harry F. Silberman

12 May 1961

SYSTEM
DEVELOPMENT
CORPORATION
2500 COLORADO AVE.
SANTA MONICA
CALIFORNIA

Permission to quote from this document or to reproduce it, wholly or in part, should be obtained in advance from the System Development Corporation.

SDC

VO250

A 1159-Rev 5/60

Experiments comparing fixed-sequence with variable-sequence methods of auto-instruction have yielded equivocal results. One study, using manually controlled auto-instructional devices and a highly simplified form of branching based on student errors, showed a saving in training time for the variable-sequence method but no difference in post-training criterion performance between this mode and the fixed-sequence mode (Coulson and Silberman, 1960). In a second experiment (Silberman, Melaragno, Coulson, and Estavan, in press), a computer-controlled auto-instructional device provided a branching pattern with more alternative paths, but with student errors on training items again used as the sole branching criterion. This method was found not to differ significantly in either training time or criterion performance from a fixed-sequence procedure.

Another study, using manual presentation techniques, compared a fixed-sequence mode with two variable sequence procedures in which the student was allowed to branch at his own option (Silberman, Melaragno, Coulson, and Estavan, in press). One of the two variable-sequence procedures was found superior to the fixed-sequence method on criterion performance, with no difference in training time.

One factor apparently influencing the success of variable-sequence auto-instruction is the nature of the branching criteria used to determine what item sequence should be given to each student. Such criteria should provide accurate evaluations during the lesson of the student's knowledge of topics which he is expected to learn. From these evaluations it should be possible to determine whether the student is ready to proceed to a new topic, or whether he requires additional instruction on the same topic.

The present experiment was designed to explore the effectiveness of a procedure in which both the student's errors on training items and his evaluation of his own learning progress were used as branching criteria. It was hypothesized that a combination of these two indices would provide effective evaluation of student progress, and that students taught with this procedure would score higher on a post-training criterion test than another group receiving fixed-sequence auto-instruction. It was further predicted that the variable sequence group would require less training time than the fixed-sequence group.

Method

Two groups of fifteen high school students were given automated instruction on logic by means of a flexible sequence, computer-controlled auto-instructional device. One group was designated the "fixed-sequence group," and the other was termed the "branching group." Every member of the fixed-sequence group received the identical sequence of 233 instructional items. Each student in the branching group was given a different number and sequence of items,

depending on his performance in responding to certain items during the lesson, and on the student's self-evaluation of his own progress.

A brief rest period was given every student toward the middle of the lesson. At the conclusion of the lesson each student received a written criterion test covering the materials in the lesson. This test was the same for all members of both groups.

Equipment

The auto-instructional device used in this study has been described in an earlier report (Coulson and Silberman, 1961). It consisted of a general purpose digital computer (Bendix G-15) coupled to a random-access slide projector and an electric typewriter. The slide projector acted under computer control in selecting a sequence of slides, each of which contained one instructional item. The subject used the typewriter to insert his answers to multiple-choice questions contained in the items, and to receive knowledge of results concerning the accuracy of his answers.

For the branching group the computer was programmed to select item sequences on the basis of three student response criteria: (1) number of response errors cumulated over a set of items relating to the same topic; (2) answers given by the subject to individual questions, where the erroneous alternative selected is indicative of a particular misunderstanding by the subject; (3) answers given by the subject to items asking whether he feels ready to advance to a new topic, or is in need of further review on an earlier topic.

If a member of the branching group made too many errors on a particular topic or expressed a lack of confidence in his own progress, he was given extra remedial materials to strengthen his knowledge of that topic. Otherwise he was taken immediately to a new topic.

For the fixed-sequence group the device merely presented each of the 233 items in sequence.

Instructional Materials

The 345 instructional items on logic used in this study were revised from materials used previously by Silberman, Melaragno, Coulson, and Estavan. Topics covered by these items included simple and compound statements, logical connectives, and six argument forms.

Materials were organized into "main stream" items using fairly large and difficult steps to cover topics, and remedial items covering the same topics with smaller and more numerous steps. Some items were written as statements,

while other items were written as diagnostic test questions. The diagnostic items, which formed the major basis for branching decisions usually included several plausible distractors and were designed to be highly discriminating of student knowledge.

A number of self-evaluation items were included in the revised materials. These items asked the student to judge his own state of knowledge on different topics.

The 233 items given to all members of the fixed-sequence group were selected by an independent consultant who was not associated with the experiment, nor with the original item preparation. The consultant was experienced in the development and experimental evaluation of self-instructional materials, and familiar with the subject area being taught. He was given the full set of 345 logic items and a list of the topics covered by the criterion test. He was asked to select from the items a sequence which he felt would provide effective instruction on the topics covered by the criterion test, and was also allowed to add any items which he believed appropriate.

Subjects

Paid volunteers from the junior and senior classes of two high schools in the Los Angeles area served as subjects in the experiment. Students were assigned to two groups of 15 subjects each. Each group contained students from both schools. The two groups were matched for average scores on the Henmon-Nelson Test of Mental Ability (Form A, Grades 9-12), administered before training. Henmon-Nelson means for the fixed-sequence group and the branching group were 112.5 (SD=12.9) and 113.8 (SD=15.9) respectively. Subjects were naive with respect to the subject matter (logic) used in the lesson.

Criterion Test

The post-training criterion consisted of 51 multiple-choice and 44 fill-in test items. Some of the questions were quite similar to the training materials while others required transfer to situations not encountered by the subject during training. The split-half reliability of the test was .97 (after Spearman-Brown correction.)

Results

The mean number of instructional items seen by members of the branching group was 213.5, with a standard deviation of 19.4. All members of the fixed-sequence group received 233 items.

Required training times and post-training criterion scores for the two groups are summarized in Table 1.

Table 1

Training Time and Post-Training Criterion Performance of Experimental Groups

		Treatment Groups	
		Branching* N=15	Fixed-Sequence** N=15
Training Time (min.)	M	116.2	129.5
	SD	20.7	26.8
Post-Training Criterion Test Scores	M	74.3	65.4
	SD	10.7	14.9
		*Average 213.5 item	**233 items

Members of the branching group averaged 8.9 points higher on the criterion test, and required an average of 13.3 minutes less training time. The difference in criterion performance was significant at the .05 level (t=2.15, df=28). A one-tail test was used since the direction of the difference was predicted in advance. The difference in training time did not reach significance.

The correlation between aptitude score and post-training criterion score was not significant for either group nor for the two groups combined.

Discussion

Results of the experiment indicate an advantage in favor of the branching procedure over the fixed-sequence mode of instruction. Student training errors and responses to self-evaluation questions provided effective criteria for branching, presumably by serving as accurate indices of student learning progress.

In an earlier study, using the same auto-instructional device and covering the same topics in logic, no difference was found between a branching and a fixed-sequence mode of instruction (Silberman, Melaragno, Coulson, and Estavan, in press). A comparison of materials and procedures used in the two experiments reveals several dissimilarities which may account for differences in the results:

1. Branching in the first experiment was based purely on training errors. The use of self-evaluation items as additional cues for branching in the present study probably increased the accuracy of evaluation of student progress.

2. In the first study practically all items contained questions. Thus most items were used for both instruction and diagnosis. In the present study some items contained only statements, while other items were written specifically as diagnostic test questions. It is probable that the use of specially designed diagnostic items afforded better estimates of student readiness to advance to new topics in the lesson, and thus made the branching more appropriate to individual student needs.

3. A remedial sequence in the earlier study contained more items with smaller steps than the main stream segment which it was intended to supplement, but both main stream and remedial items used the same basic approach in presenting the facts or concepts to be learned. The revised remedial items used in the present experiment approached topics differently than their corresponding main stream items. Thus, where the main stream items taught a particular topic deductively the remedial items might teach the same topic inductively. It is likely that the revised remedial materials were more effective in allowing students who had encountered obstacles on the main stream items to view the concepts being presented in a new perspective.

4. In the first study each member of the fixed sequence group received the same sequence of items as a "mate" in the branching group. The only difference between the two groups was that the sequence was determined on the basis of errors made during the lesson by the branching group member, whereas this same sequence was given to the fixed-sequence group member without regard to his performance on the materials. To further equate conditions for the two groups, knowledge of results messages for both groups contained only the number of the correct answer.

   One consequence of the attempt to hold conditions identical for the two groups in the first experiment was that certain types of branching and certain remedial materials could not be used in the

branching condition. For example, no remedial items or knowledge of results messages could be given that referred specifically to the student's answer to the previous item, since such a message would have been inappropriate for the fixed-sequence group "mate" who might have given a different answer.

In the present experiment no attempt was made to equate exactly the materials seen by the two experimental groups. Members of the branching group were often given remedial items containing specific references to answers which they had given to preceding items. These remedial materials were designed to correct misunderstandings evidenced in the earlier responses. A remedial item, for example, might say, "No, you gave the answer ' $\vee$ ' when you should have answered ' $\wedge$ '. Remember, ' $\wedge$ ' represents "and" while ' $\vee$ ' represents "or." Thus the revised materials used in the present experiment were much more closely adapted to the needs of individual branching group members than was possible in the initial study.

In summary it appears that the branching procedure used in the present experiment provided more accurate diagnoses of student needs than was possible in the earlier study, and more effective remedial materials for filling these needs. Some support for this conclusion is given by the fact that the correlation between student aptitude and criterion score was significant in the first study, but not in the second. This finding indicates that the remedial materials in the later experiment raised the performance of lower aptitude students to that of the higher aptitude students, although the lower aptitude students required more training time to reach this level. Since there was no aptitude-criterion correlation in the second study for either the branching group or the fixed-sequence group the reduction of student performance differences cannot be attributed entirely to the branching procedure. The fact that some of the items used for remedial purposes in the branching group were included in the materials selected for the fixed-sequence group may account for the lack of correlation between aptitude and criterion score in the fixed-sequence group.

Summary

Two groups of high school students received instruction in logic from a computer controlled auto-instructional device. For one group, the device operated in a fixed-sequence mode, presenting the same sequence of 233 items to all subjects. In the second group, designated the "branching group," each subject received a different number and sequence of items, depending on the subject's performance during the lesson. Branching decisions were based on student errors in responding to diagnostic items in the lesson and on the student's evaluation of his own readiness to advance to new topics.

Students in the branching group who exceeded specified performance criteria were taken quickly through the materials with a minimum number of items, while students who performed poorly were given additional materials until they demonstrated satisfactory knowledge of the topics. On the average, members of the branching group saw 213.5 items.

Dependent variables were student performance on a post-training criterion test, and required training time. Criterion scores were significantly higher (.05 level) for the branching group than for the fixed-sequence group; training time differences were not significant. No correlation was found between student aptitude and criterion test performance.

Comparisons were drawn between this experiment and an earlier study of similar design in which no differences were found between fixed-sequence and branching modes of operation. Results of the present study were attributed to the accuracy with which diagnostic items revealed the needs of the branching group, and to the effectiveness of remedial materials in filling these needs, particularly for subjects of lower aptitudes.

References

Coulson, J. E., & Silberman, H. F. Effects of three variables in a teaching machine. J. educ. Psychol., 1960, 51 (3), 135-143.

Coulson, J. E., & Silberman, H. F. Automated teaching and individual differences. Audiovisual Communication Rev., 1961, 9(1), 5-15.

Silberman, H. F., Melaragno, R. J., Coulson, J. E., & Estavan, D. P. Fixed-sequence versus branching auto-instructional methods. J. educ. Psychol., (in press).